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Open Source Ventilator System using IOT

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Abstract: *Corona virus Disease 2019 (COVID-19) threatens to overwhelm our medical infrastructure at the regional level causing spikes in mortality rates because of shortages of critical equipment, like ventilators. Fortunately, with the recent development and widespread deployment of small-scale manufacturing technologies like Rap-class 3-D printers and open source microcontrollers, mass distributed manufacturing of ventilators has the potential to overcome medical supply shortages. In this study, after providing a background on ventilators, the academic literature is reviewed to find the existing and already openly-published, vetted designs for ventilators systems. These articles are analyzed to determine if the designs are open source both in spirit (license) as well as practical details (e.g. possessing accessible design source files, bill of materials, assembly instructions, wiring diagrams, firmware and software as well as operation and calibration instructions). Next, the existing Internet and gray literature are reviewed for open source ventilator projects and designs. The results of this review found that the tested and peer reviewed systems lacked complete documentation and the open systems that were documented were either at the very early stages of design (sometimes without even a prototype) and were essentially only basically tested (if at all) ..*

Keywords: IOT, Amu Bag, Arduino uno, SPO2/Heart rate Sensor

I. INTRODUCTION

An open-source ventilator is a disaster- situation ventilator made using a freely licensed (open-source) design, and ideally, freely available components and parts (open-source hardware). Designs, components, and parts may be anywhere from completely reverse-engineeredorcompletelynewcreations,componentsmaybeadaptationsofvarious inexpensive existing products, and special hard-to-find and/or expensive parts may be 3D-printed instead of purchased. The first mechanical ventilators date back to more than 150 years ago. In the time since, they have undergone considerable design modifications; including, crucially, the transition from pure mechanical devices to the modern electronic machines in use to day. Despite their commercial availability, very few plat forms have been made open and fullytransparent.Suchaplatformwillenabletheproductionofhigh-qualitydevicesinvirtually any laboratory, will further efforts in teaching and research/development, and may serve as development platform for a future medical tool.

In addition, over the past years, the global COVID-19 pandemic has highlighted the need for a low-cost, rapidly-deployable ventilator solution for the current and future pandemics. While safe and robust ventilation technology exists in the commercial sector, the re exist a small number of suppliers who have been unable to meet the extreme demands for ventilators during a pandemic. Moreover, the specialized and proprietary equipment developed by medical device manufacturers can be prohibitively expensive and inaccessible in low-resource areas. Ventilation as a technology is needed globally beyond pandemics for applications spanning neonatal intensive care, surgical anaesthesia, life support, and general respiratory treatments.

Finally, while the COVID-19 pandemic sparked a surge of interest in ventilation designs and some truly creative solutions, nearly all technologies put forth during this time have focused on evaluating performance with respect to adult guidelines. However, ventilation is of critical importance in paediatric medicine and it is valuable to consider developing a solution that is suitable for both adult and paediatric indications. Hence there is a clear need for a broader range of solutions, both for research (e.g. to improve critical components, clinical applications, and beyond.

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In response to these challenges, we present an open-source, rapid-deploy ventilator design with minimal reliance on specialized medical devices and manufacturing equipment. The People's Ventilator Project (PVP1) is a pressure-controlled and fully automatic mechanical ventilator that can be built for $1,700 by a single person in few days. As a point of reference, the lower-end average market values of open ventilators such as the freely-released Puritan Bennett 560 or the Mechanical Ventilator Milano cost approximately $10,000. PVP1's parts were selected for widespread availability, and its modular software was designed to support component substitutions and extensions to new ventilation modes. Further, we have included comparisons here to commercial, pediatric-grade ventilators to emphasize the versatility of PVP1 and the goal of increasing global access to critical-care ventilation technology and making such technology available for teaching and research.

Need of Project:

Patients with basic lung sickness may create respiratory disappointment under an assortment of difficulties and can be bolstered mechanical ventilation. These are machines which precisely help patients move and breathe out, permitting the trading of oxygen and carbon dioxide to happen in the lungs, a procedure alluded to as fake breath. While the ventilators utilized in current emergency clinics are exceptionally practically and innovatively complex, their obtaining expenses are correspondingly high.

Objective of Project:

The clinical objectives of mechanical ventilation can be highly diverse: To maintain gas exchange, to reduce or substitute respiratory effort, to diminish the consumption of systemic and/or myocardia O2, to obtain lung expansion, to allow sedation, anaesthesia and muscle relaxation, and to stabilize the thoracic wall.

1. To save time 1and money
2. To make easy to use ventilator
3. To Reduces unwanted cost of technical manpower
4. To display the heart rate and spo2 of patient so that nurse or doctor can change ventilator configurations
5. Build a continuous positive airway pressure device.
6. Helps you breathe when you're sick, injured, or sedated for an operation.
7. It pumps oxygen-rich air into your lungs. 8. It also helps you breathe out carbon dioxide, a harmful waste gas your body needs to get rid of.

II. LITERATURE SURVEY

The execution of closed loop control of tidal volume parameter which is controlled in mechanical ventilators utilized at serious consideration units (ICU) and veterinary resources for exploratory examinations was actualized by H. Güler and F. Ata, which reduction the remaining burden of clinicians. L.D'Orsi,A.Borriand A.DeGaetano built up the first version of a simple butrealistic physiological lung ventilation mathematical model. The patient-ventilatorcomplexisconsideredbydemonstratingtheweightwaveprovidedbythemechanical lung ventilator as an external (control) input. R. Robert, P.Micheau, O. Avoine, B. Beaudry, A. Beaulieu and H. Walti, planned a vigorous controller to perform weight managed expiratory stream and to execute it on the most recent fluid ventilator model (Inolivent-4) utilizing Numericalreproductionsandreasonedthatweightcontrolledventilationincrediblystreamlines the utilization of the fluid ventilator, which will surely encourage its presentation in escalated care units for clinical applications.

Borello has just proposed the structure of an adjustment plot for a steady and exact control of air and oxygen gas for ventilators. This new controller offers uniform following of dynamic stream reference flag over the full scope of patient burden from huge grown-up to little new born child in this way requiring no manual (from the earlier) determination in the controlstructureoritsadditionstomodifyforpatientsize.Mustafahasgottenthemathematical models of known and used air flow and volume signals in clinical medicine, LabVIEW and MATLAB/Simulink condition based reproductions for a Pressure-controlled ventilator. Volyanskyy has built up a neuro-versatile control design to control lung volume and

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moment ventilation with information weight imperatives that likewise represents unconstrained breathing by the patient.

A microcontroller based advanced control of a modern application is produced for the situating control of a ventilator cylinder in a fake breath gadget. A model mechanical ventilation arrangement of a lung test system was proposed for trial ponders. Reproduction and experimental studies on the air flow dynamic of the mechanical ventilation framework were done dissected. The ideal determination of mechanical ventilator settings that guarantee satisfactory oxygenation and carbon dioxide leeway while limiting the danger of ventilator- related lung damage (VALI) is a critical test for concentrated consideration clinicians and has been structured by AnupDas.Maria has dissected the contrasts among volume and weight controlled ventilation demonstrating that weight controlled ventilation allows a more reliable compensation of breathing circuit compressible volume.

Toyama assessed the exactness of three unique ventilators to convey little VT during volume-controlled ventilation. Hussain proposed Synchronized Intermittent Mandatory Ventilation mode control utilizing Pulse Oximeter that is shabby, exact and simple to use to program state in a sensible spending plan improving well-being offices in poor nations like Bangladesh.

III. METHODOLOGY

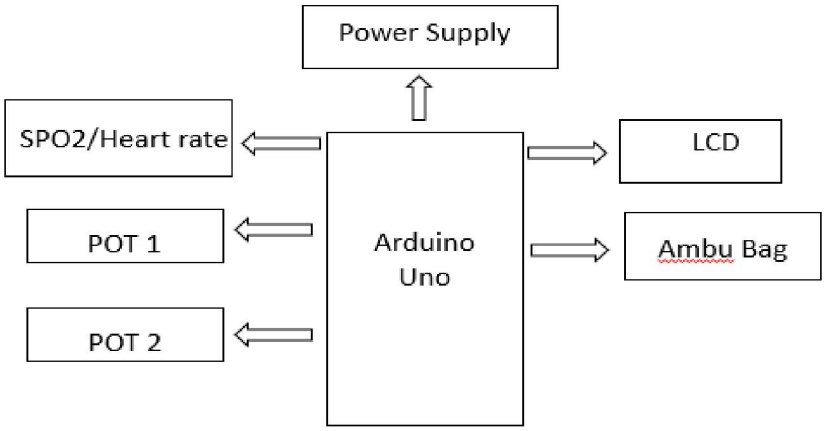

Fig. 1. Block Diagram

1. Amid the global crisis caused by the corona virus pandemic, hospitals and healthcare facilities are reporting shortages of vital equipments.
2. As makers it's our responsibility to combat the shortage by constructing makeshift-open-source substitute devices. Our country might be in a lock down but our ingenuity
3. One important device for which demand has ramped up is ventilators for patients who need assistance with their breathing due to the respiratory effects of COVID-19.
4. Basically a ventilator is a machine that provides breathable air into and out of the lungs, to deliver breaths to a patient who is physically unable to breathe, or breathing insufficiently.
5. A DIY ventilator may not be efficient as that of a medical grade ventilator but it can act as a good substitute if it has control over the following key parameters Tidal volume: It's the volume of air delivered to the lungs with each breath by the

• ventilator - typically 500ml at rest.
• BPM (Breaths per minute): This is the set rate for delivering breaths.
• Inspiratory: Expiratory ratio (IE Ratio): refers to the ratio of inspiratory
• time: expiratory time.
• Flow rate: is the maximum flow at which a set tidal volume breath is delivered by the ventilator

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• Peep (Positive end expiratory pressure): It is the pressure in the lungs above atmospheric pressure that exists at the end of expiration.

My design is based on the automation of the manual BVM (Ambu-bag), which you can find in any medical supply store. It is a hand-held device commonly used to provide positive pressure ventilation.o ground.

Methodology

A ventilator is a machine that relaxes for the patient or encourages patient to relax. It is likewise called a breathing machine or respirator. The ventilator is associated with a PC with handles and catches that are constrained by a respiratory specialist, medical caretaker, or specialist. It has tubes that are associated with the individual through ha breathing cylinder. The breathing cylinder is put in the patient's mouth or in an opening in the neck into the windpipe (trachea). This opening is known as a tracheostomy

It makes clamours and has cautions that alarm the social insurance group when something should be fixed or changed. An individual gets the medication to stay agreeable when associated with the ventilator, particularly when they have a breathing cylinder in their mouth. The prescription may make quiet too lethargic to even think about opening their eyes or remain conscious for in excess of a couple of minutes. Patient can't talk on account of the breathing cylinder. At the point when patient is alert enough to open their eyes and move, they can impart recorded a sa hardcopy. Quiet on ventilator shave numerous wires and cylinders on them. That may look unnerving; however these wires and cylinders help the specialists to painstakingly screen them. Some patient's may have limitations on them. These are utilized to keep them from pulling off any significant cylinders and wires.

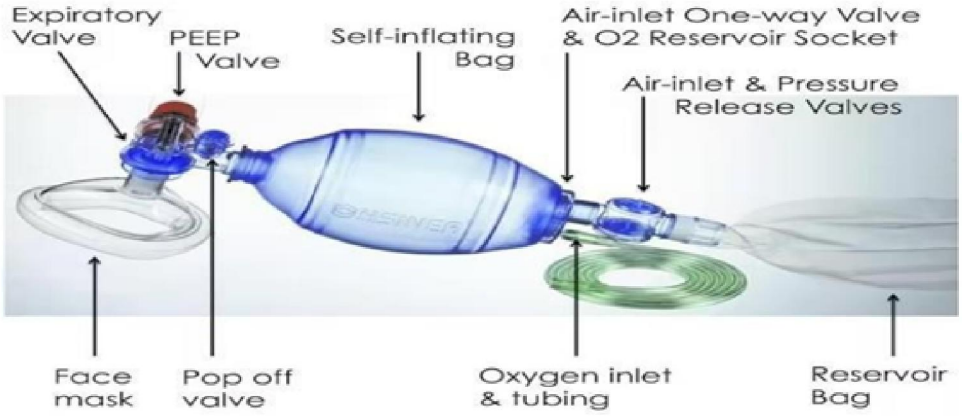

Fig. 2. Hardware system design

Patientsareputonventilatorswhentheycan'tinhalealone.Thismightbeforany of the accompanying reasons:

• To ensure that the patient is getting enough oxygen and is disposing of carbon dioxide.

• After medical procedure, the patient may require a ventilator to inhale since they may havebeengivenafewmedsthatreasonthemlethargicandtheirbreathinghasnotcome back to typical.

• A patient has a sickness or damage and can't inhale ordinarily. More often than not, a ventilator is required distinctly for a brief span like hours, days, or weeks. Be that as it may, at times, the ventilator is utilized for a considerable length of time, or now and then years. In the emergency clinic, an individual on a ventilator is observed intermittently by medicinal services suppliers including specialists, attendants, and respiratory advisors. Patients who need ventilators for extensive stretches may remain in long haul care offices. A few patients with tracheostomy might almost certainly be athome.Tolerantonaventilatorarewatchedcautiouslyforlungdiseases.Atthepoint when associated with a ventilator; a patient gets an opportunity of hacking out bodily fluid. In the event that bodily fluid gathers, the lungs can't get enough oxygen. The bodily fluid can likewise prompt pneumonia inpatient. To dispose of bodily fluid, the method called suctioning is required. This is finished by bringing a little slender cylinder into the patient's mouth or neck opening to vacuum out the bodily fluid. At the point when the ventilator is utilized for in excess of two or three days, the patient

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may get nourishment through cylinders into them either a vein or their stomach. Since the patient can't talk, exceptional end eavorsare should be made to screen the man furnish them with some other approaches to communicate. The block diagram of the a ventilator. Block diagram of a Ventilator attached which were be acting as diaphragm, the major working principle of diaphragm is interlocking the inhalation air within the test lung bag through closing exhalation valve holes which is near by diaphragm, at another condition of exhalation state the diaphragm is completely opened to leave away the air which is intake at the state of inhalation period. The amount of air at inhalation period and exhalation period is same amount. Shows the pressure sensor board developed.

IV. SYSTEM DESIGN

Component Description

A. Arduino uno

The Arduino Uno development board is based on the Atmel ATmega328, an 8-bit, 16 MHz microcontroller with 14 digital input/output (I/O) pins, 6 of which are capable of pulse-width modulation (PWM), as well as a 6-channel, 10- bit analog-to-digital converter. Digital communication capabilities include UART TTL serial, SPI serial, and twowire interface serial (I2C). The Arduino development platform features a cross-platform, Java-based IDE as well as a C/C++ library which offers high-level access to hardware functions. LCD has 2 Power Sources.

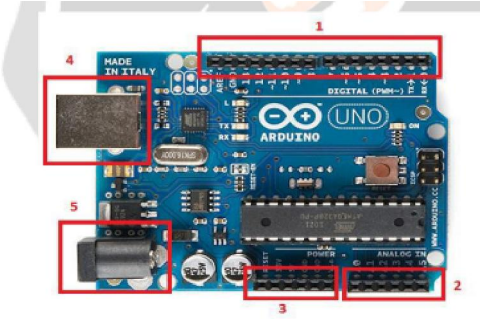

Fig. 3. Arduino Nano

B. Servo Motor

A servo motor is defined as an electric motor that provides precise control of angular or linear position, speed, and torque using a feedback loop system.

Fig. 4. Servo Motor

C. LCD Display

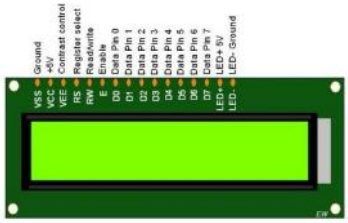

Fig. 5. LCD Display

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A 16x2 LCD (Liquid Crystal Display) Module is a common type of character display used in various electronic projects. Here is the specification typically associated with a standard 16x2 LCD module: when using a16x2 LCD module, you typically control it by sending commands and data through a microcontroller such as an Arduino or raspberry Pi, allowing you to display information like sensor reading, messages, or menu options.

D. LCD Display

ECG Monitor Sensor Module is based on AD8232 Analog Device IC. This is a cost-effective ECG Sensor used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analogy reading. ECGs can be extremely noisy, out AD8232 Single Lead Heart Rate Monitor acts as an opam pto help obtain aclearsignal.ThissensorcanbeconnectedtoanArduino/RaspberryPi,etc.Samplecodesare easily available on the internet.

Fig. 6. ECG Sensor

E. Thingsspeak IOT

Things Speak is a versatile IOT platform that is widely used for implementing open source ventilation with advanced features like real time monitoring, data analytics, and control capabilities. • When integrated with IOT – enabled Ventilation, Things Speak allows for seamless communication Temperature sensor, Heart Bit sensor, Heart rate sensor. • One of the day advantages of using Thigs Speak app conjunction with IOT – based open source ventilation its ability to collect and analyse large volumes of data generated by the open source ventilation. • To show graph Things Speak app easy to analysing data of Temperature sensor, Heart bit sensor, Heart rate Sensor

V. CONCLUSION

There is clear technical potential for alleviating ventilator shortages during this and future pandemics using open source ventilator designs that can be rapidly fabricated using distributed manufacturing. The results of this review, however, found that the tested and peer-reviewed ventilator systems lacked complete documentation and that the current open systems that were documented were either at the very early stages of design or had undergone only early and rudimentary testing. With the considerably larger motivation of an ongoing pandemic, it is assumed these projects will garner greater attention and resources to make significant progress to reach a functional and easily replicated open source ventilator system. There is a large amount of technical future work needed to move open source ventilators up to the level considered adequate for scientific-grade equipment and further work still to reach medical-grade. Future work is needed to achieve the potential of this approach not only on the technical side, but lso by developing policies, updating regulations and securing funding mechanisms for the development and testing of open source ventilators for both the current COVID19 pandemic, as well as for future pandemics and for everyday use in low-resource settings. The designing and development of Power Supply for Ventilator is done through UPS system. The designing of various components is done according to the Texas Instruments Standards and the obtained values are verified by simulating

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the circuit in the MATLAB Software. In the proposed system, the DC power supply of 48V is designed for the Mechanical Ventilator by implementing Forward converter along with Boost PFC converter Circuit. Both the converters are closed-loop controlled in order to get the required constant output voltage. The filtering is done using low pass filter for filtering the dc input fluctuations. Feedback is taken from the converter output and fed to the PID controller and PID Controller is used for controlling output voltage using proportional, Integral and derivative combination

VI. RESULT

• Data Saving: The system allows for the storage and saving of monitored data, temperature readings.
• Graphical Representation: The system provides graphical representation of the monitored data, allowing for easy visualization and analysis of battery performance temperature variations
• In summary, the expected results include enhanced temperature regulation, stability and reliability of the Heart rate sensor monitoring, graphical representation for easy visualization and analysis, data analytics capabilities to identify usage patterns, detect anomalies, and provide performance trends considering temperature variations, such as low change.

Fig. 7. IOT Screenshot

ACKNOWLEDGMENT

It gives us great pleasure in presenting the paper on " Open Source Ventilator System Using IOT". We would like to take this opportunity to thank our guide, Prof. Borkar S.V., Professor, Department of ETC Engineering, Vidyaniketan College of Engineering, Bota, for giving us all the help and guidance we needed. We are grateful to him for his kind support, and valuable suggestions were very helpful.

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